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FLIGHT TESTS ON THE LATERAL CONTROL OF AN AIRPLANE
HAVING A SPLIT FLAP WHICH RETRACTS AHEAD
OF CONVENTIONAL AILERONS

By Fred E. Weick
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INTRODUCTION

Since the recent more or less extensive adoption of high-lift flaps on airplane wings, the problem of providing satisfactory lateral control without sacrificing a part of the span of the flaps has become one of some importance. The difficulties have been largely a matter of obtaining satisfactory rolling moments with a smoothly graduated action, together with sufficiently small control forces throughout the entire speed range. As part of an investigation including several different lateral-control arrangements to be used with split flaps, the tests reported in this paper were made on one arrangement in which conventional ailerons of narrow chord are used, and a split flap is retracted into the under surface of the wing forward of the ailerons.* When the flap is retracted, the arrangement is as sketched in figure 1(a). If a simple form of split flap were used, hinged at its forward edge, the appearance when deflected would be as shown in figure 1(b). The flap if deflected with its leading edge remaining in this forward position would give somewhat less than three fourths of the lift increase of the same flap in the usual rear position. (See reference 1.) If, as shown in figure 1(c), the split flap ahead of the aileron is moved to the rear as the trailing-edge portion is deflected downward, a double advantage is obtained. The deflected flap can be located in the most effective region for high lift (reference 1), and the force required to deflect the flap is reduced. This is the arrangement used in the present tests.

*Another lateral-control device which has been found to operate satisfactorily with full-span flaps was described in a recent memorandum report, entitled "Retractable Ailerons for Use with Flaps", by Floyd L. Thompson.

With the flap retracted, the wing and ailerons operate in the normal manner of present conventional airplanes. The narrow ailerons should ordinarily require reasonably low control forces, but if desired they may be balanced to reduce the hinge moments by any of the ordinary means, such as the inset hinge. The balancing would be ineffective when the flap was in the extended position, but at the low air speeds obtained with the flap deflected, it is probable that the aileron control force would not be excessive.

PRELIMINARY WIND-TUNNEL TESTS

The probability that the conventional ailerons would give reasonably satisfactory control with the split flap extended was suggested by the results of wind-tunnel tests (not yet published) on a wing with a simple split flap and upper-surface ailerons. A typical set of results which were obtained in the N.A.C.A. 7 by 10 foot wind tunnel are given in figure 2. A comparison of these results with those of tests on ordinary conventional ailerons of the same size (references 2 to 5, inclusive) shows that with the split flap deflected the upper-surface ailerons give rolling moments and hinge moments of approximately the same magnitude as the ordinary ailerons on a plain wing. The yawing moments are also approximately the same, except for the extreme aileron deflections. The values of all three types of moment are the same even for downward deflections sufficiently great to permit the use of ordinary differential aileron linkages. Thus, it seemed that conventional ailerons of the proper size might give reasonably satisfactory lateral control when used together with deflected split flaps.

It was considered that the wind-tunnel tests on simple split flaps and upper-surface ailerons represented the desired conditions sufficiently closely that further wind-tunnel tests were unnecessary before full-scale tests were made to show the action in flight.

DESCRIPTION OF ARRANGEMENT FOR FLIGHT TESTS

A special wing with the desired flap and aileron arrangement (fig. 3) was built for the Fairchild 22, a small parasol monoplane. The appearance of the special wing as

tested is shown in figure 4. The ailerons had a chord of 9 inches, or 13.6 percent of the wing chord. They were provided with a differential linkage giving a maximum upward deflection of 25° and a maximum downward deflection of 14° . No aerodynamic balance was used for it was thought that with the narrow-chord ailerons on a relatively small and lightly loaded airplane the control forces would be satisfactorily light. The flap was made 20 percent of the wing chord and had a total deflection of 60° with a rearward movement of the front edge of the flap of about 16 percent of the wing chord. Both the flap and the ailerons covered the entire span except for the rounded wing tips and a small cut-out in the center.

A somewhat higher value of the maximum lift coefficient could have been obtained with a larger flap, say 30 percent of the wing chord, both because of the larger size and because it could be moved rearward a greater distance. (See reference 1.) In the application of the flap to the wing of this particular airplane, however, it seemed structurally desirable to have the flap in its retracted position located entirely behind the rear spar, which limited its size. The arrangement as tested gives within about 15 percent of the value of the maximum lift coefficient obtainable with a larger flap, and is considered satisfactory to show the effectiveness of the conventional ailerons with this type of flap.

TESTS

The present tests were of a qualitative nature, the results having been obtained through the pilots' observations. It is the present intention to measure the rolling and yawing action resulting from the use of the ailerons in flight, and to publish these data in a more complete report later.

With the flaps retracted the conventional ailerons operated in the usual manner. They gave satisfactory rolling control throughout the unstalled flight range, but did not give control at angles of attack above the stall. Small adverse yawing moments were noticeable. The control force was light.

With the flaps down the rolling control seemed approximately the same as it was at the same air speed with the flaps up, but became noticeably less responsive as the

speed was reduced to the minimum obtainable with the flaps down. The control was, however, considered sufficient for all normal flying including landing under gusty air conditions. The ailerons operated satisfactorily with the flap deflected any amount, a smooth well-graduated change in "feel" being noticeable between the extreme positions. The control force with the flap down seemed slightly greater than it was at the same speed with the flaps up. The difference is considered by the pilots to be in the order of 15 or 20 percent. Control at angles of attack above the stall was not obtained with the flap in any position. With the flap down the adverse yawing moments given by the ailerons were somewhat more noticeable than with the flaps up.

CONCLUSION

From the results of these preliminary qualitative tests this arrangement of split flap and conventional ailerons appears to give reasonably satisfactory lateral control in unstalled flight with full-span flaps.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., December 22, 1933.

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N.A.C.A.

Fig. 1

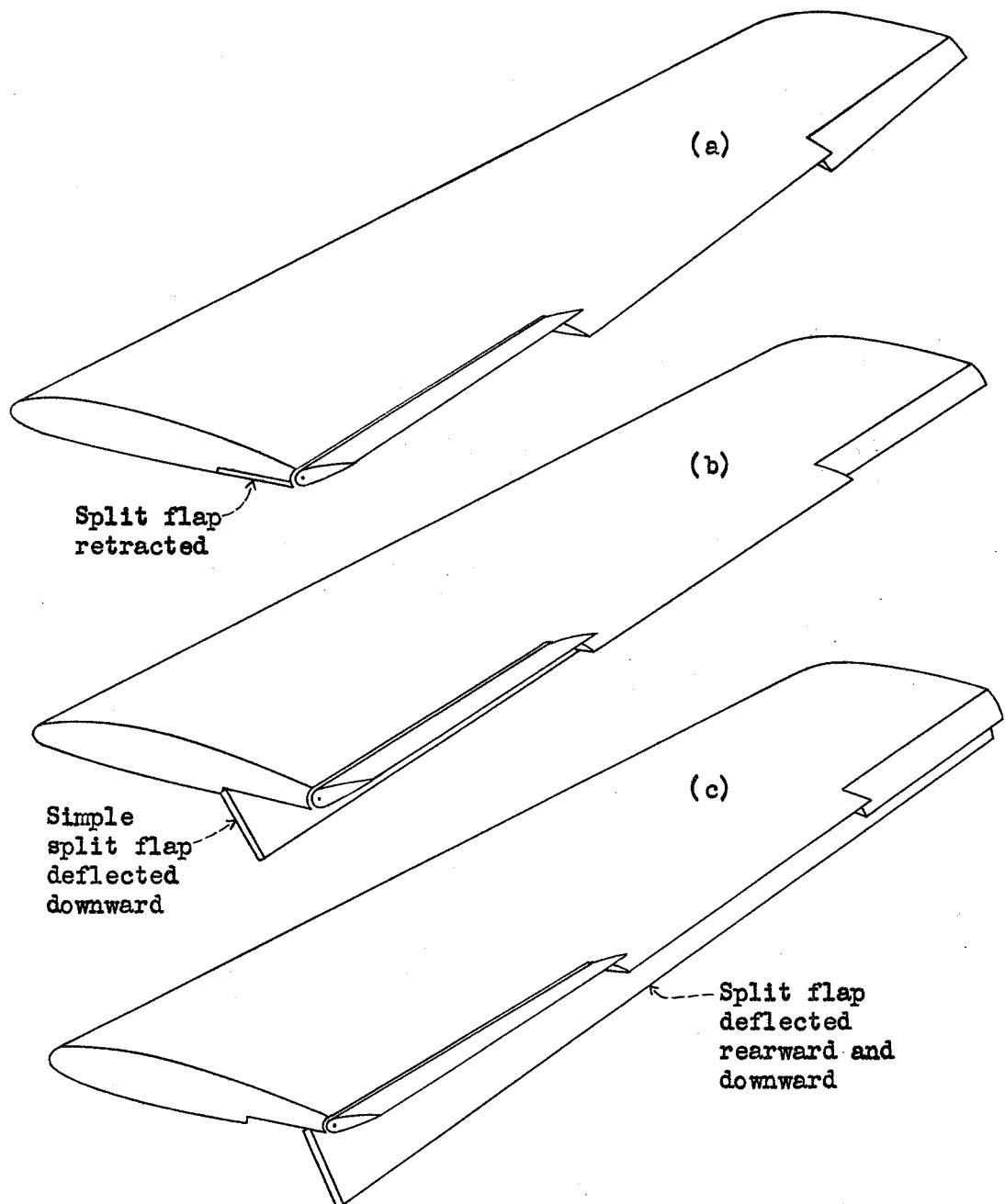


Figure 1.- Split flaps mounted ahead of narrow conventional ailerons.

N.A.C.A.

Fig. 2

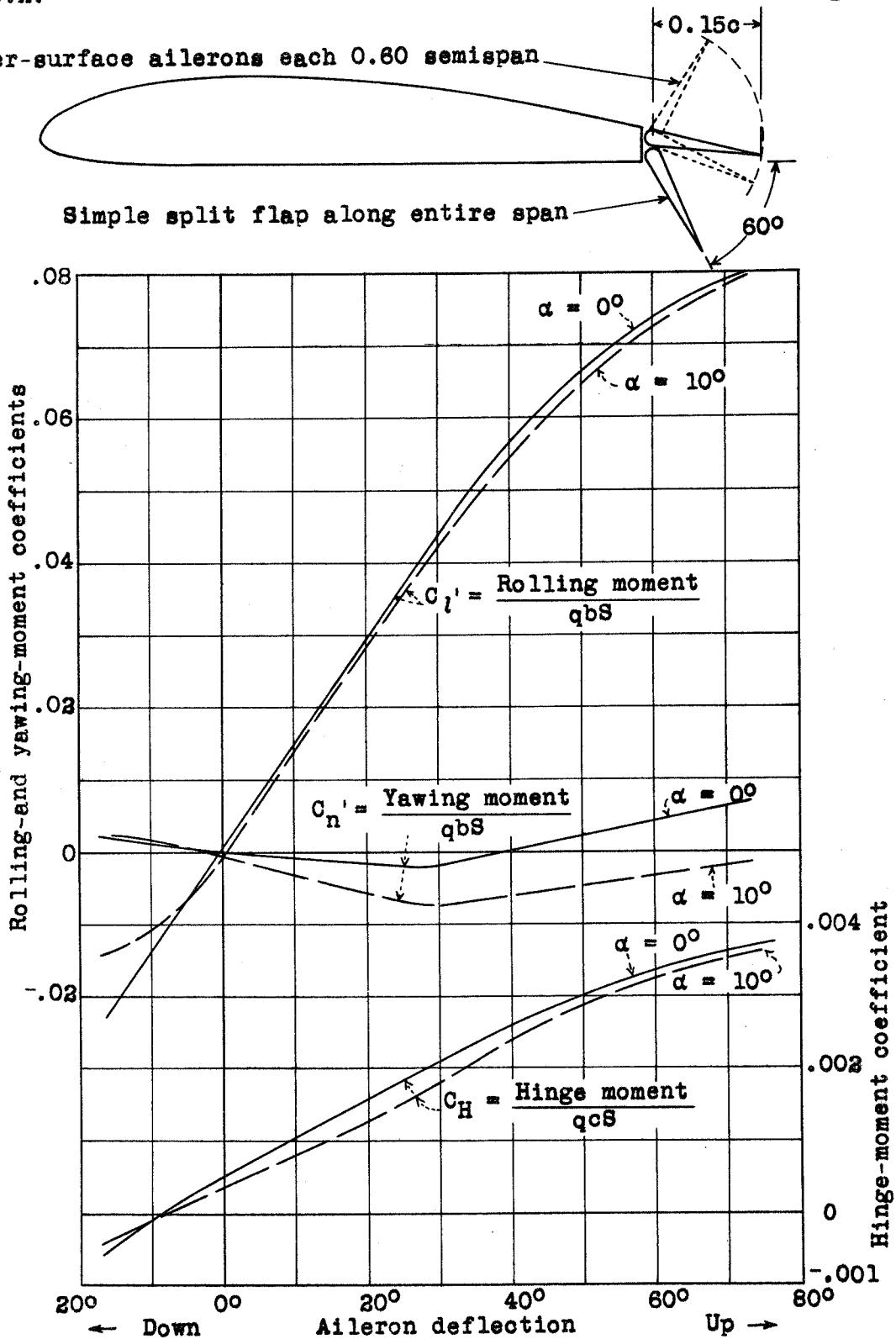


Figure 2.- Wind-tunnel test results with upper-surface ailerons and split flaps.

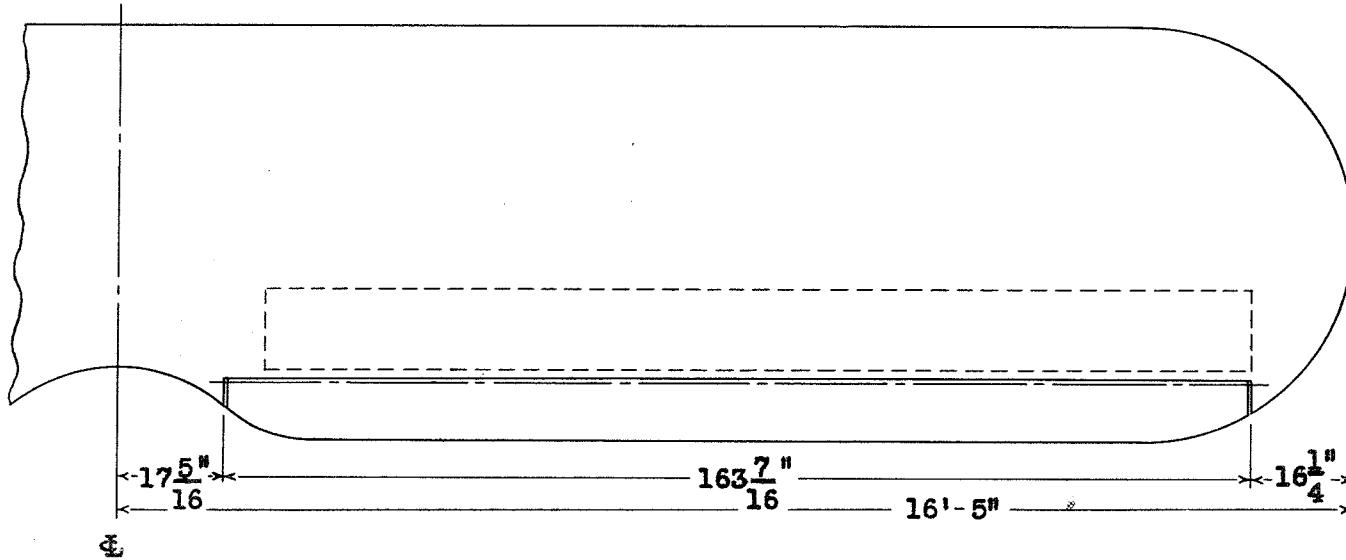


Fig.

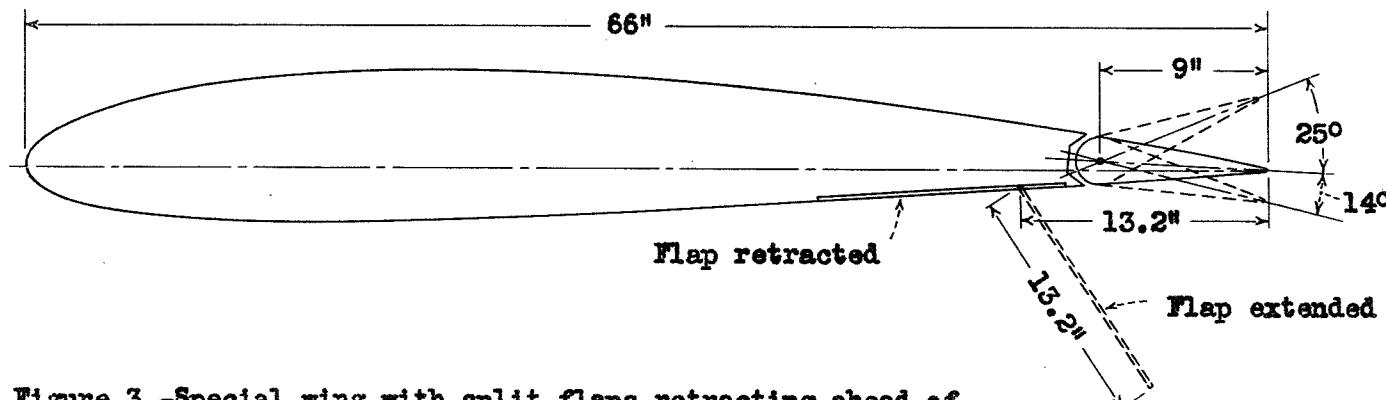


Figure 3.—Special wing with split flaps retracting ahead of conventional ailerons.



Figure 4. - F-22 airplane with special wing